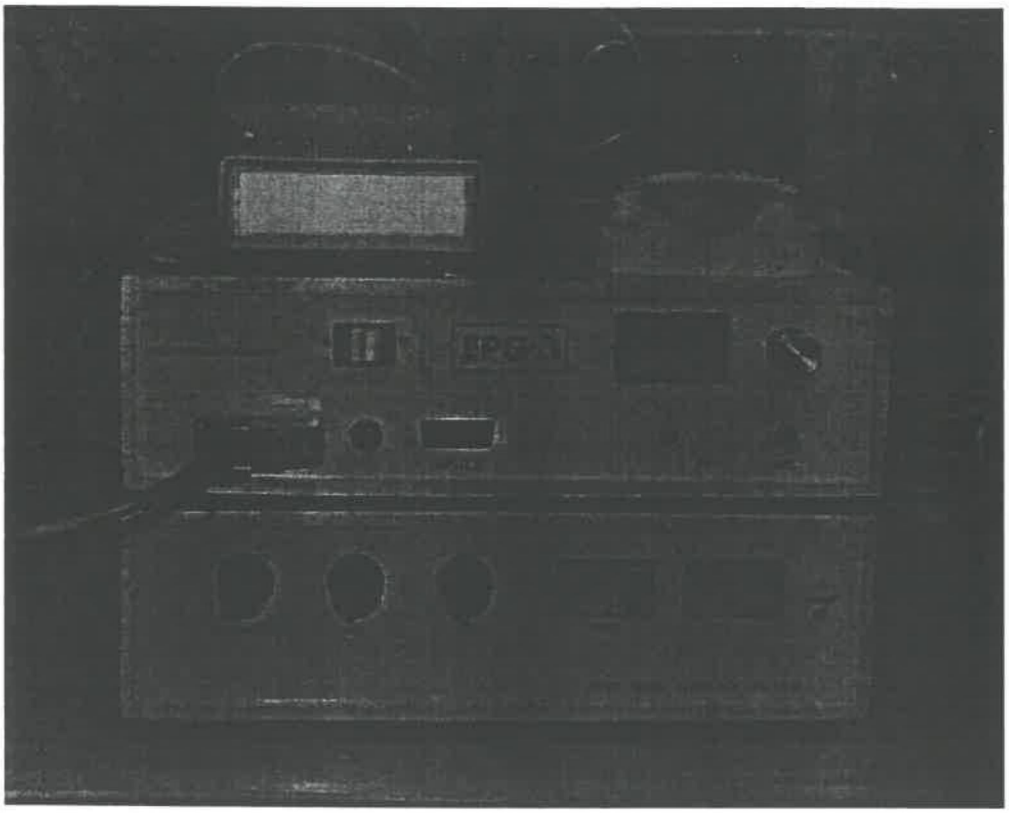
ELECTROPALATOGRAPH EPG3 AND SPI V1.0 SERIAL PORT INTERFACE FOR WINDOWS 95/98

USER'S MANUAL



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Edinburgh

1. INTRODUCTION

Electropalatography (EPG) is a technique that records details of the timing and location of tongue contacts with the hard palate during running speech. The contacts are detected by 62 silver electrodes arranged on the surface of a thin acrylic palate which is moulded to fit the subjects upper dentures. The subject wears the acrylic palate, and holds an electrode to complete the electrical contact circuit energized by a low level high frequency signal. The electrodes are scanned by the EPG3 palate scanner which passes the lingual-palatal contact information to a computer, via the serial port interface (SPI) for display, storage and analysis.

The SPI contains a small DOS computer which controls the EPG3 scanner under the instruction of the host computer connected by an RS232 9,600 Baud serial link to the COM1 or COM2 port. This method eliminates the need for any special hardware or drivers within the host computer running under Windows 95 or higher.

Analogue signals accompanying EPG sessions are directed to the host computer sound system requiring a sample rate of 10kHz to retain compatibility with earlier (legacy) DOS recordings. Some audio cards, such as SBLive inhibit the selection of a 10kHz sample rate and cannot be used.

Two software packages are provided. REAL EPG enables real time display and recording of palates. ANALYSE EPG enables recorded EPG sessions to be played back, analysed and annotated.

The ANALYSE software provides a facility for converting .epg and .wav legacy files to the new .epg + RIFF.wav standard. The ANALYSE software may therefore be used in support of previous EPG3 sessions within a Windows 95 or higher computer with audio facilities.

Whilst the ANALYSE program is supported by some print features for full printout of windows, TechSmith's SNAGIT has been bundled with the installation. This excellent facility permits any screen display to be sent to the printer or to the clipboard for transfer to other Windows programs.

Both REAL and ANALYSE programs are subject to ongoing development.

EPG HARDWARE SYSTEM

Electropalatography requires the following hardware:

1) Custom built electropalate
2) EPG3 Scanner and multiplexer
3) Serial Port Interface (SPI)
4) Windows 95 or higher Multimedia Computer with serial com port
5) Microphone and Loudspeakers.

Electropalate

The electropalate is the fundamental basis for electropalatography and requires to be manufactured to fit the subject's upper dentures exactly. This is achieved by getting a dentist to provide a mould of the upper dentures which may be used to build the acrylic palate fitted with the 62 silver contacts and the required wiring to the multiplexer input connector.

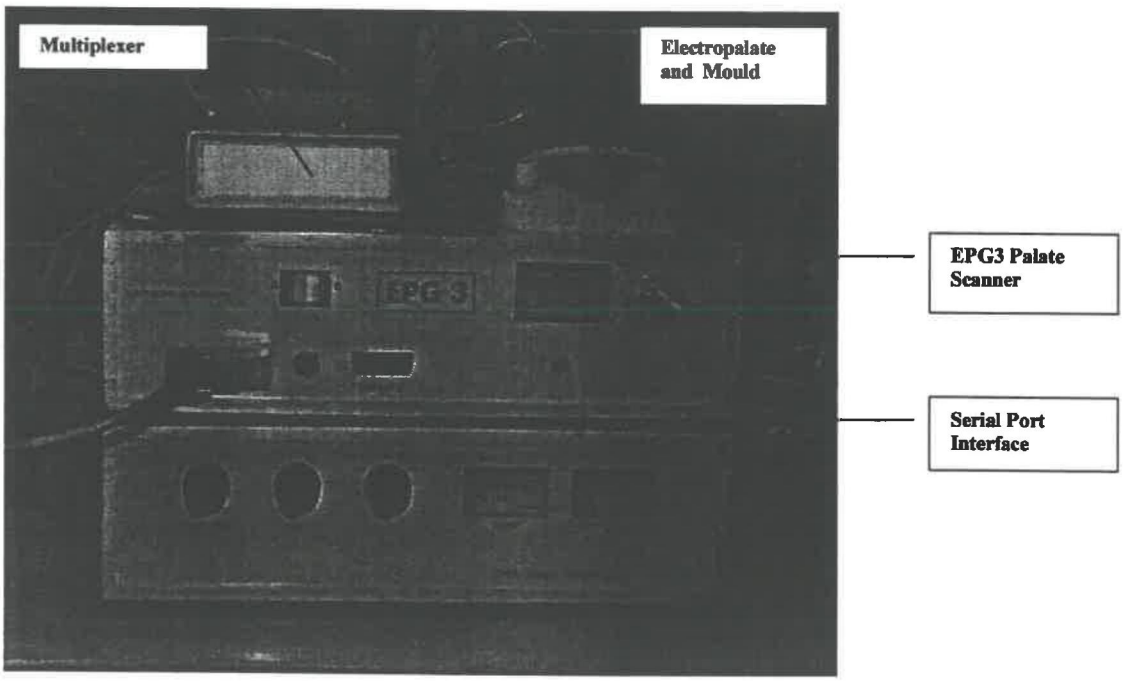


Fig. 1. Hardware system.

The electropalate plugs into the connector slot on the multiplexer which is suspended from a lanier around the subjects neck. The subject should hold the return electrode which plugs into the side of the multiplexer box to complete the contact circuit. The purpose of the multiplexer is to reduce the 62 electropalate contacts down to a 4 wire cable connection to the EPG3 scanner unit INPUT.

Two INPUT connectors A & B are provided to enable a therapist to alternately view the subject and the therapist's own palate for demonstration purposes. A second multiplexer is required to support this mode of operation.

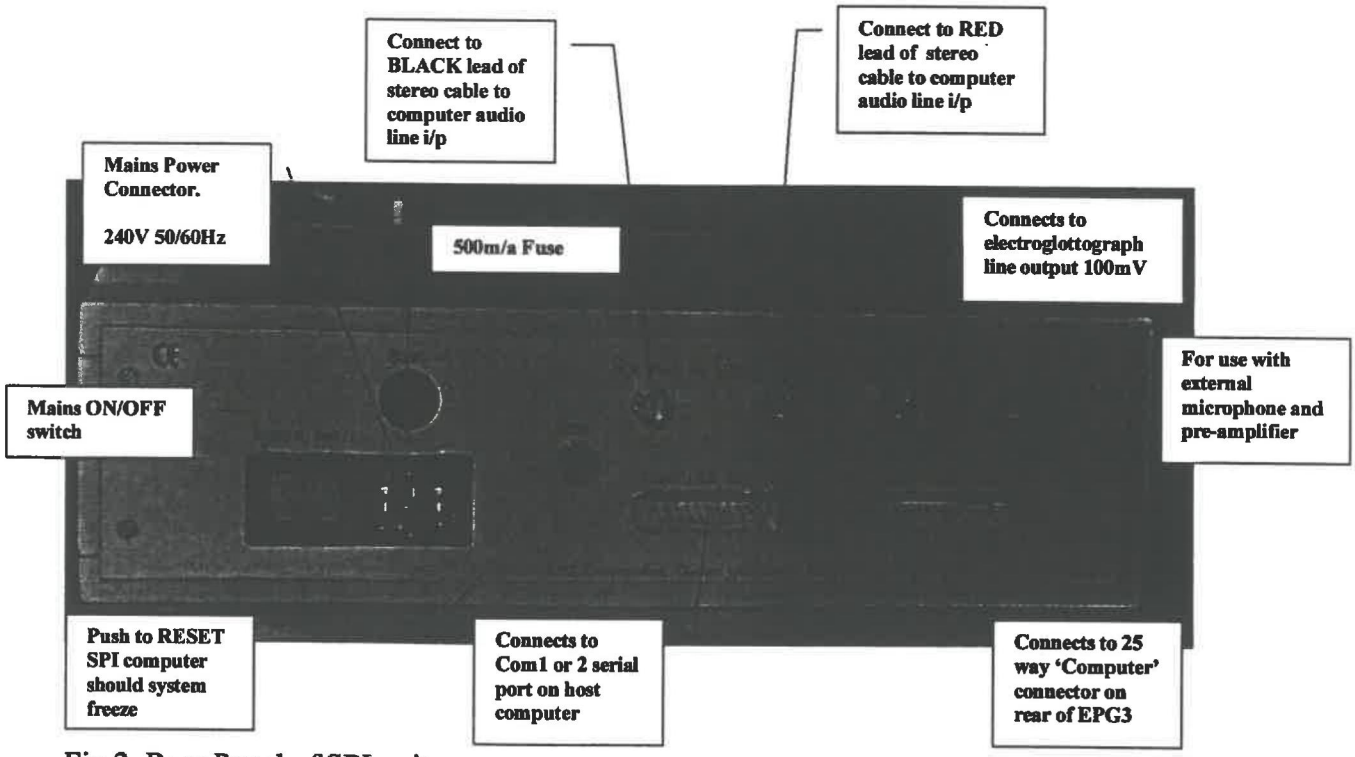

Connect to BLACK lead of stereo cable to computer audio line i/p
Connect to RED lead of stereo cable to computer audio line i/p
Mains Power Connector.
240V 50/60Hz
500m/a Fuse
Connects to electroglottograph line output 100mV
For use with external microphone and pre-amplifier
Mains ON/OFF switch
Push to RESET SPI computer should system freeze
Connects to Com1 or 2 serial port on host computer
Connects to 25 way 'Computer' connector on rear of EPG3

Fig.2. Rear Panel of SPI unit.

Serial Port Interface Connections

The SPI powers the EPG3 scanner and controls its operation in response to instructions from the host computer. The short 25 way ribbon cable should be connected between the EPG3 'Computer' and the EPG CONTROL connector. The longer ribbon cable may be used to connect the host computer COM1 or COM2 serial port and the COMPUTER RS232 connector on the SPI rear panel. An adaptor is provided to enable a 9 pin computer port to be connected to the 25 way ribbon cable.

SOFTWARE INSTALLATION

Two Sets of software discs are provided. ANALYSE should be loaded first since it includes the database engine used by both ANALYSE and REAL programs.

Insert Disc 1 of 7 of the ANALYSE program in the floppy drive and run a:\setup.exe. Load the remaining ANALYSE discs as requested until the program loading is complete.

Insert Disc 1 of 2 of the REAL program in the floppy drive and run a:\setup.exe. Load the second REAL setup disc when requested and let the process run to completion.

SYSTEM TESTING

Switch on the SPI by operating the switch on its rear panel. Observe the front panel LED to confirm that the SPI is powered.

Switch on the EPG3 by operating the switch on its rear panel. Observe the EPG3 front panel LED to confirm that the EPG3 scanner is powered.

Click on EPG Enterprises in the host computer Main Menu.
Click on EP to start the REAL EPG software.

Click on 'Configure' so set up the host computer comport link

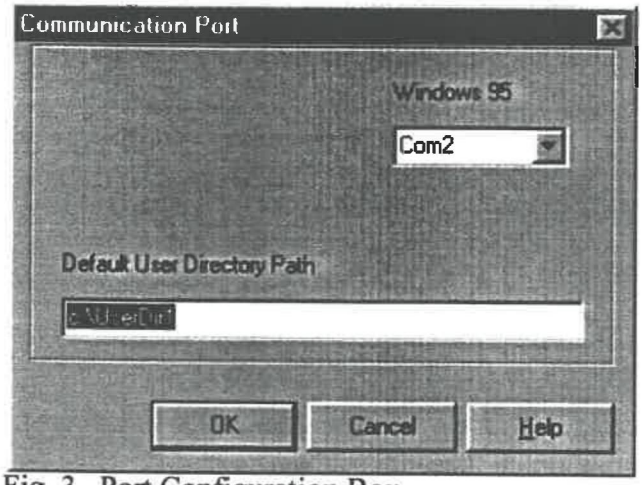


Fig. 3. Port Configuration Box

The configuration screen allows the choice of the appropriate Com Port to match the port which the SPI serial link has been connected to. The default user directory path should be set to a directory which you intend your EPG session files to be stored. When you are

satisfied that the correct information has been entered click OK and then close the dialogue box.

Next Click REAL to start the real time palate display and click Single Palate to reach the screen as shown below

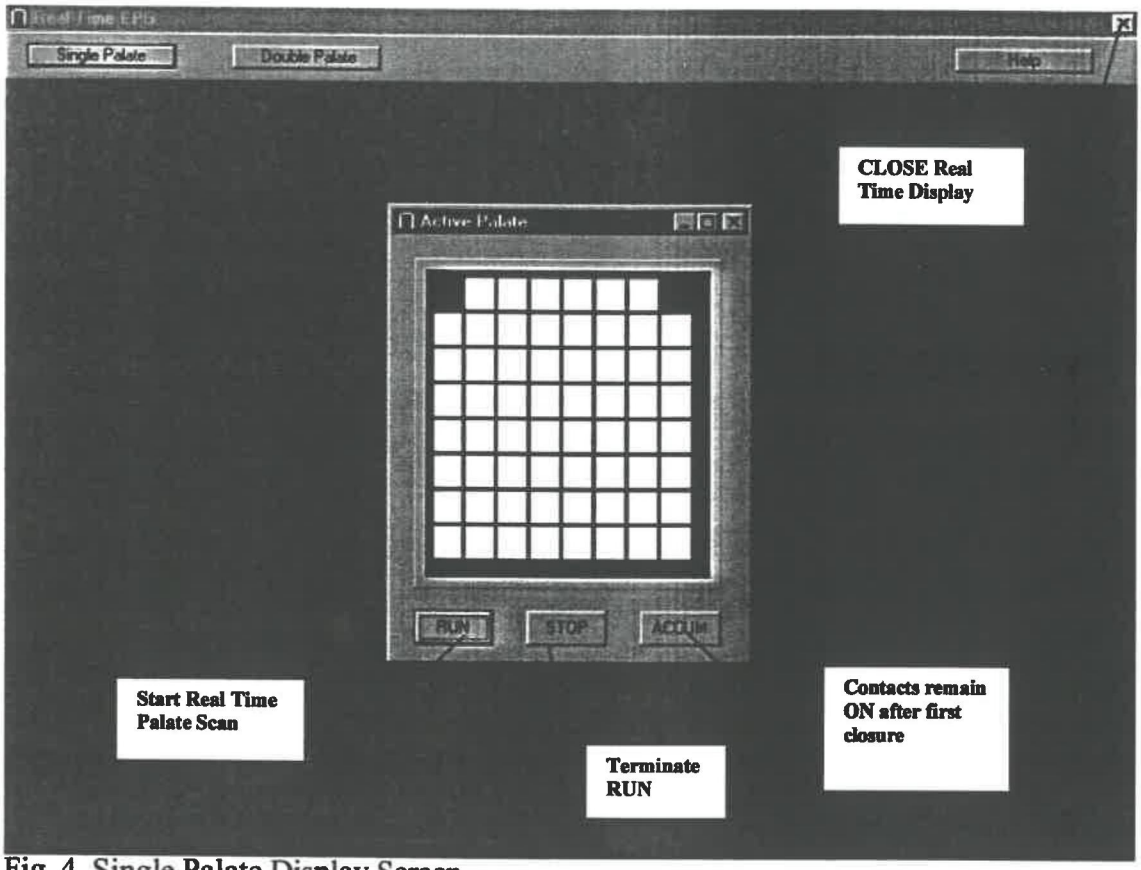


Fig. 4. Single Palate Display Screen

Next click RUN on the active palate window. The contact area should turn RED to indicate that communication has started successfully with the SPI and EPG3 scanner. If the display remains WHITE then there is no communication or the SPI is not running. Check the serial lead is in place and that you have entered the correct com port in the Configure process. Try pressing the RED RESET button on the rear of the SPI. If there is still no change to RED then there is a fault which must be located and cleared.

If the palate contacts have changed to RED then either insert a palate and observe tongue contacts whilst holding the hand electrode or stroke the multi-plexer socket with a coin whilst holding the hand electrode. In either case, the screen should show live contacts as white rectangles. I this happens, then the hardware is functioning correctly.

Testing Palate CAPTURE.

From main screen select CAPTURE then follow the sequence below:

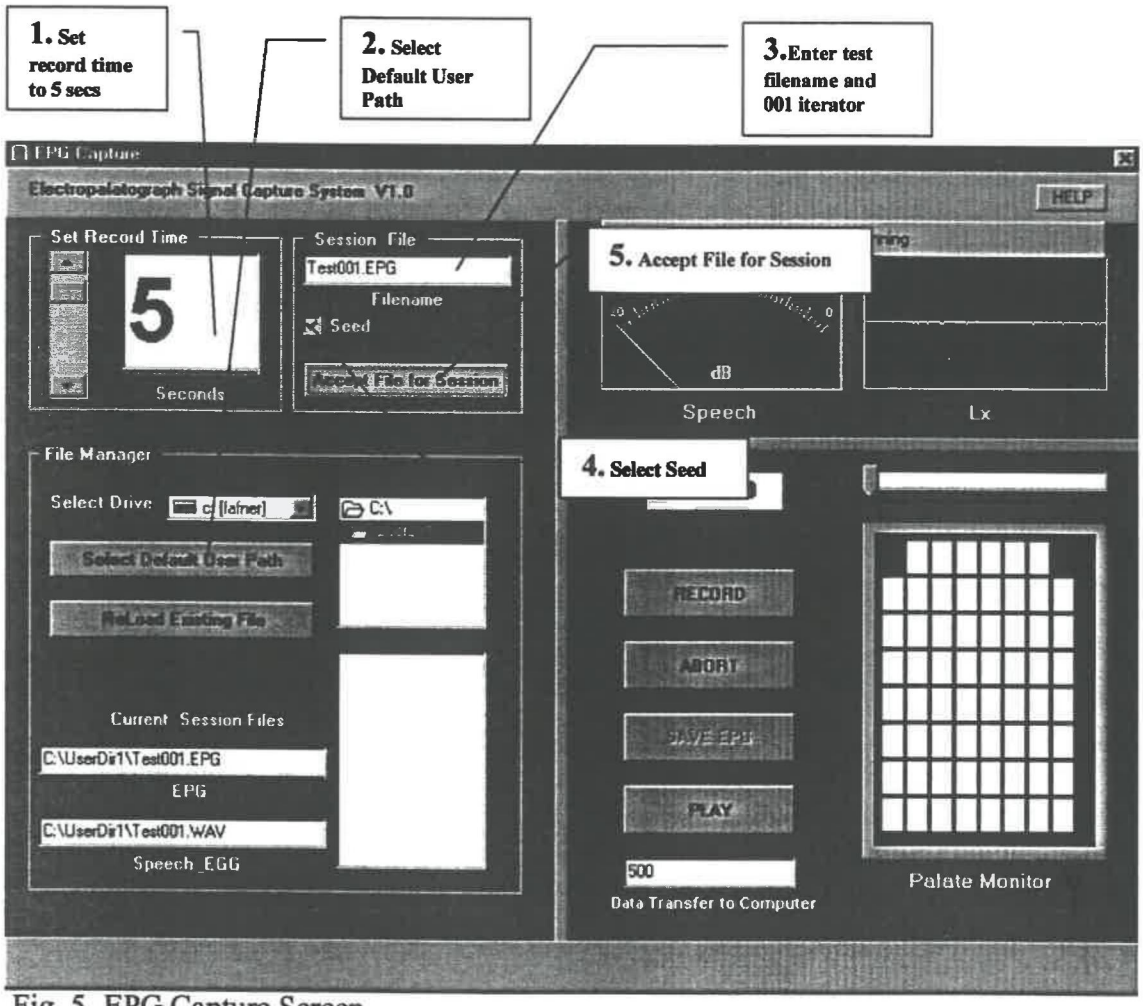


Fig. 5. EPG Capture Screen

Setting up a capture session involves:

1. Setting a duration time for the recording session
2. Selecting a destination for the session files
3. Entering a .epg filename ending in 3 numerical digits (if the seed utility is to be used)
4. Selecting the SEED option (if desired)
5. Accepting these details for recording.

At the end of stage 5 the names of the .epg and .wav files will be displayed in the bottom left hand text boxes and the number of palates to be captured will appear in the 'Data Transfer to Computer' text box.

The system is now ready to make a recording. Microphone levels may be set by observing the left hand on screen VU Meter. If an electroglottograph is connected to the SPI then the right hand 'Oscilloscope' display should be used to set the level of the EGG signal and to observe its waveform to confirm proper positioning of the neck electrodes. The MONITOR facility may be toggled ON/OFF by clicking on the label above the two displays.

Setting the levels of the analogue signals for voice and EGG is accomplished by using the level controls on the front of the SPI. In addition if the EPG3 microphone channel is used then the level control on the EPG3 front panel should be set to achieve an adequately high level on the EPG3 VU meter.

Finally click on RECORD. A short tone burst will be heard (<0.5sec) and the record counter will count up to around 5.3 seconds. The additional time is accounted for by the actual time that it takes for the sound card to initialize and begin recording. The end of the tone burst becomes a time datum to sync Voice and EPG start of recording. When the EPG file is saved, the tone is stripped off to leave voice and EPG starts within a few uS of each other.

At the end of the recording, the Data Transfer to Computer text box begins to show the bytes transferred to the host computer. For a 5 second recording this will be 5x100x8+1=4001 . If this figure is not correct, then a framing error will have occurred indicative of a serial port problem. If this figure is 4001, then the EPG capture system is working correctly.

When the Data has been transferred to the host computer i.e. 4001 is seen, then click on the SAVE EPG button.

The PALATE MONITOR does not display anything until the slider above the display is dragged across its range. This enables the palates to be inspected. Pressing play enables the voice data to be heard. (The palate display will eventually display during the recording session and during playback when the software has been developed).

If these tests have been successful then the EPG system is working.

HARDWARE TOPICS

The operation of the SPI interface requires that the host computer has a serial port available to assign to the EPG system. Communication is at 9,200 Baud using hardware handshaking. The host computer com port is configured by the REAL software. The modest 9,200 Baud rate should achieve reliability however running concurrent network

or download tasks should be avoided in order to keep the interrupts as low as possible to reduce the risk of data being lost and frame errors occurring. Because there are so many variables which come into play such as machine speed, INI file settings and replaceable COMM.DRV files it is impossible to predict how well a serial port communication will perform. In the worst case scenario it may be necessary to use a third party intelligent serial port board which offloads serial interrupt processing tasks from the CPU. Such problems have not been observed with any installations so far but it is anticipated that problems may occur simply because of the impossibility of second guessing the performance of all computers.

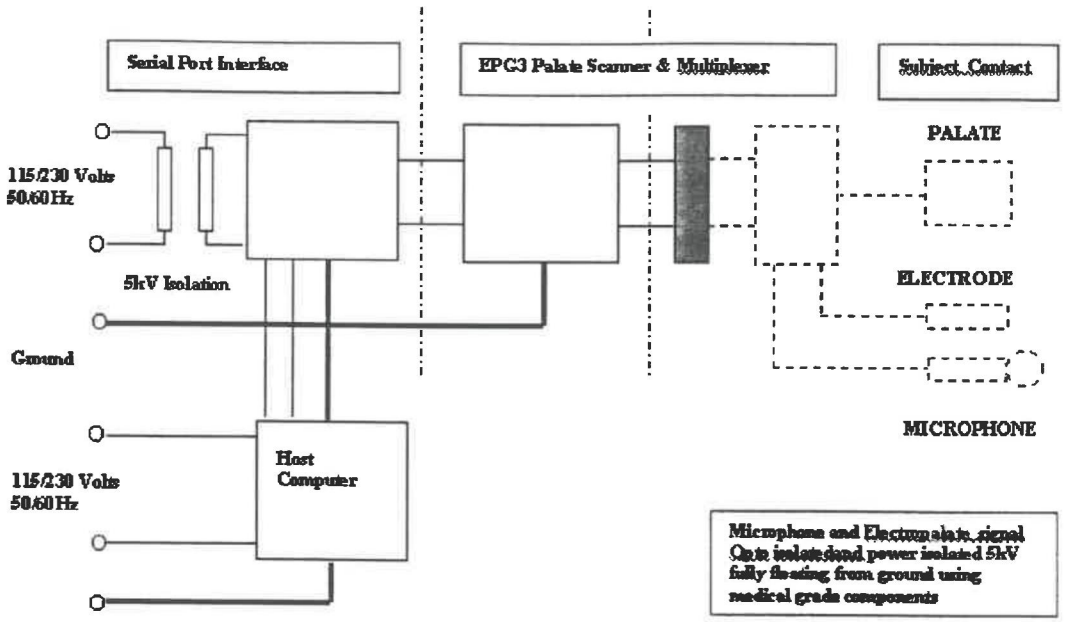
Computer sound cards are a further potential source of problems. Creative Labs for instance have inhibited the use of other than the standard sample rates in their SBLive cards. The AWE64 and SB16, ESS systems etc appear to tolerate the requirement to record at 10kHz and not 11.025kHz. (This problem will be shortly eliminated by enabling an 11.025kHz EPG .WAV pair of files to be utilised. The EPG software packages assume a Creative Labs compatible sound system.

The video display resolution required for the EPG software packages is 800 x 600 pixels with a colour depth of > 256 if good grey scale spectrograms are to be printed.

The requirement for system RAM is mainly defined by the requirements of the Windows operating system when meeting normal multi-media demands. It is generally the rule that plenty of RAM memory will speed up displays, printing and the ability to accomplish more than one task simultaneously. Not less than 64Mb of RAM is suggested but better performance will be achieved from 128Mb.

Electrical Safety Considerations

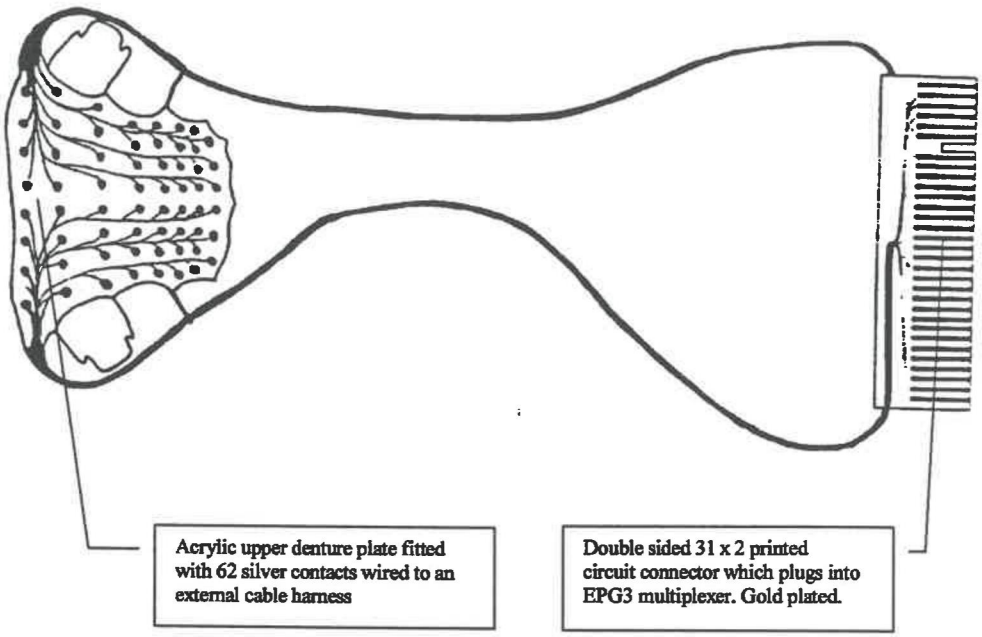
The electrical safety of EPG has been a major consideration during design of the system hardware with fully floating opto-isolation of the electropalate accomplished. The subject safety features are largely a matter for the EPG3 scanner and multiplexer which are responsible for energizing the current flow between the tongue and hand held electrode.



Warning !!

Safety of the electropalate wearer depends upon isolation of the components in contact with the subject from ground and from the mains power supplies. Nothing should be connected to the patient contact components which might compromise the isolation provided. If in any doubt over this requirement, consult a competent electrician.

ELECTROPALATE ASSEMBLY


Acrylic upper denture plate fitted with 62 silver contacts wired to an external cable harness
Double sided 31 x 2 printed circuit connector which plugs into EPG3 multiplexer. Gold plated.

The essential component of the EPG system is an artificial palate custom built to fit the subject's mouth. This is made from acrylic, moulded to fit the upper palate and teeth, and carries 62 miniature silver electrodes exposed to the lingual surface. These are arranged according to a predetermined scheme based upon anatomical landmarks. This ensures adequate coverage of the entire palate including such phonetically important areas such as the region near the junction between the hard and soft palates and the lateral margines close to the teeth. The procedure involves first marking the positions for the electrodes on a plaster model of the subject's upper palate and teeth. Three reference lines are then traced out on the surface:

i) a line drawn horizontally across the top of the model through the palatal junctures of the upper front incisors.
ii) A line drawn horizontally through the mid-point of the juncture between the hard and soft palates.
iii) A line drawn vertically down the centre of the palate.

The 62 electrode positions are arranged in eight horizontal rows with eight electrodes in each row, except the first (the most anterior) which has six (see Figure).

The most anterior and most positive rows constitute the two horizontal reference lines ([i] and [ii] above). Along these lines the electrode positions are marked out at equidistant intervals with the most lateral ones just inside the teeth. The remaining rows are arranged so that the spacing between the front four row contacts is half of that of the back four row

contacts. As with the first (most anterior) and eighth (most posterior) rows, the contact positions are equally spaced across the rows. The electrode positions are marked out on the plaster cast and used as a guide for placing the electrodes during the palate manufacturing process.

The electrodes themselves are thin silver discs, 1.4mm in diameter, each connected to a 46cm length of 41 s.w.g. enameled copper wire. The bundles of wires are brought to the posterior corner of the palate, usually behind the wisdom teeth (in adults) and are fed out of the mouth via the buccal surfaces of the maximilliary dentition. The wires are protected by soft heat-shrink tubing.

The choice of anatomically-based reference lines and the proportional spacing of the electrodes ensure that different palate sizes can be compared with reference to specific rows and electrode positions during articulation analysis. Thus for example, row number three (third from the edge of the alveolar ridge) will stand will stand in more or less the same relationship to the palate and teeth in different subjects.

MANUFACTURE OF THE PALATES

The process of manufacturing the palates is a relatively skilled process and is currently carried out by two firms of dental technicians in the U.K.

1. Broughton and Tyrrell,
   Greenham Common,
   Newbury,
   Berkshire.

2 Grove Orthodonetics,
59, Neville Road,
King's Lynn,
Norfolk.

In order to manufacture a palate, there manufacturers need to have a full impression or cast of the upper palate and teeth. These can be obtained by conventional procedures from any dental practitioner. The impression should be accurate, free of air bubbles and extend back as far as the junction between the hard and soft palates. A plaster cast is then made from this impression.

A number of requirements must be met before the acrylic palate is satisfactory.

It is obviously important that the palate interferes as little as possible with normal speech production. It should be as thin as possible, but at the same time robust enough to tolerate frequent use and thick enough to keep its shape accurately. An exact fit is essential and the palate should not move even when considerable pressure is exerted on the posterior edge, as may happen for example during the closure for a velar stop. It is a

routine procedure to issue users with a "practice palate". This is a duplicate palate but without contacts and wires, which can be taken home and worn for increasing periods of time prior to clinical sessions. When the palate is worn for the first time, increased salivation normally occurs, but this effect subsides after wearing the palate for a few hours. Occasionally a user is sensitive to the presence of the palate in the mouth. This is usually overcome after it has been worn a few times.. The age of the user does not appear to be a significant factor in tolerating the palate. Some as young as four years old have found the palate quite comfortable to wear.

Audio recordings can be made with and without the palate being worn in order to estimate the effect that the presence of the palate is having upon speech. It has been the experience at Reading that, so long as there has been an adequate adaption perion, speech is not noticeably affected when the palate is worn.

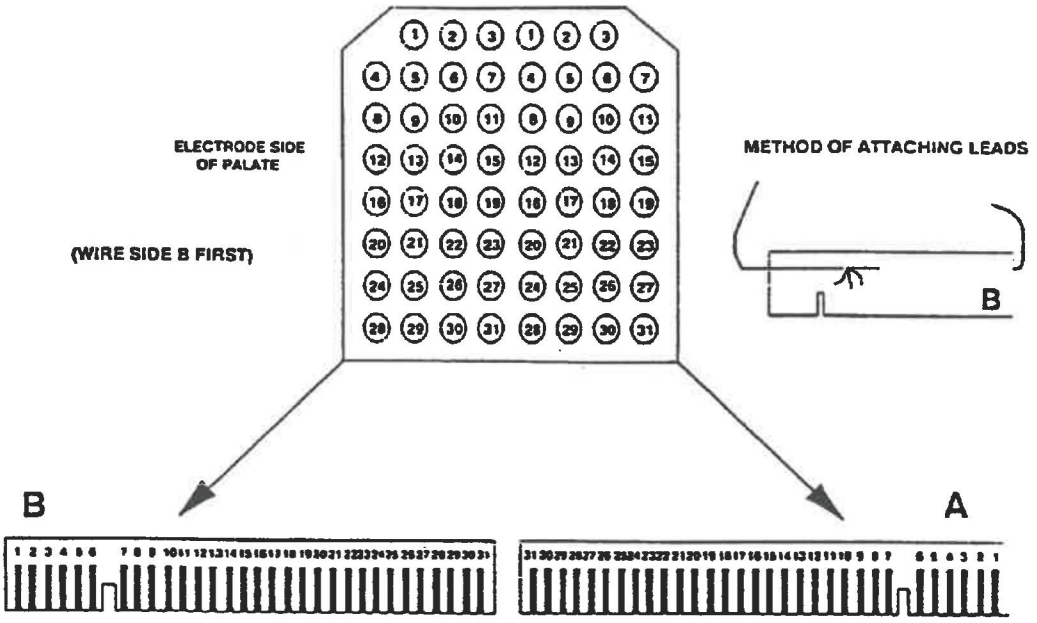
If a user wears a denture, then it is a straightforward procedure to make a duplicate denture with electrodes embedded in it. This has the added advantage of not requiring an adaption period, since the user will already be used to wearing the denture. Children's teeth can move slightly over a period of time, or they may lose teeth. This may happen, for example, if the child requires EPG treatment which extends over a considerable length of time. In these circumstances, it is advisable for a dentist to adjust the wire retention clasps.

Care of the Artificial Palate

To clean the palate after use, rinse in warm water, and if necessary clean with a soft toothbrush and mild detergent (**keep the multiplexer connector dry**). Wipe dry with tissues. Always place the palate back on the plaster cast when not in use. Try not to subject the wires to any undue tension, or coil them excessively.

Wiring Connections for the Palate

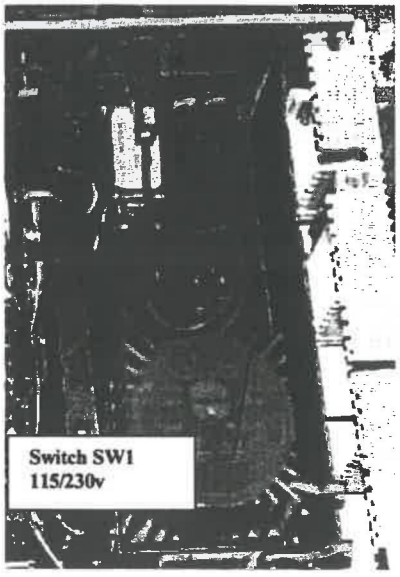
Figure below shows the correspondence between the electrodes and the actual contacts on the connector plug.



Mains 115 volts/230 volts selection

Mains voltage setting for U.S. 110V 60 Hz supplies may be used to power the EPG3/SPI system.

Selection may be achieved by setting an internal switch under the safety cover of the power supply unit within the SPI..



To alter the setting:

1. Remove the SPI case lid by unscrewing the four screws retaining the case feet.
2. Remove the aluminium cover which protects the high voltage components of the power supply.
3. Select the desired 115v or 230v position using SW1
4. Replace the safety cover and close case.

NB THE MAINS LEAD MUST BE DISCONNECTED FROM THE SPI BEFORE ANY ATTEMPT IS MADE TO OPEN THE SPI CASE. APPLYING THE INCORRECT MAINS VOLTAGE MAY DAMAGE THE EQUIPMENT. CONSULT WITH A COMPETENT ELECTRICIAN IF YOU HAVE ANY DOUBTS AS TO YOUR SUPPLY VOLTAGE.